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Direct leaf wetness measurements and its numerical analysis using a multi-layer atmosphere-soil-vegetation model at a grassland site in pre-alpine region in Germany

Genki Katata (1), Andreas Held (2), and Matthias Mauder (3)

(1) Karsruhe Institute of Technology (KIT), Germany/Japan Atomic Energy Agency, Japan (genki.katata@partner.kit.edu), (2) University of Bayreuth, Germany, (3) Karsruhe Institute of Technology (KIT), Germany

The wetness of plant leaf surfaces (leaf wetness) is important in meteorological, agricultural, and environmental studies including plant disease management and the deposition process of atmospheric trace gases and particles. Although many models have been developed to predict leaf wetness, wetness data directly measured at the leaf surface for model validations are still limited. In the present study, the leaf wetness was monitored using seven electrical sensors directly clipped to living leaf surfaces of thin and broad-leaved grasses. The measurements were carried out at the pre-alpine grassland site in TERestrial ENvironmental Observatories (TERENO) networks in Germany from September 20 to November 8, 2013. Numerical simulations of a multi-layer atmosphere-SOiL-VEGetation model (SOLVEG) developed by the authors were carried out for analyzing the data. For numerical simulations, the additional routine meteorological data of wind speed, air temperature and humidity, radiation, rainfall, long-wave radiative surface temperature, surface fluxes, ceilometer backscatter, and canopy or snow depth were used. The model reproduced well the observed leaf wetness, net radiation, momentum and heat, water vapor, and CO_2 fluxes, surface temperature, and soil temperature and moisture. In rain-free days, a typical diurnal cycle as a decrease and increase during the day- and night-time, respectively, was observed in leaf wetness data. The high wetness level was always monitored under rain, fog, and snowcover conditions. Leaf wetness was also often high in the early morning due to thawing of leaf surface water frozen during a cold night. In general, leaf wetness was well correlated with relative humidity (RH) in condensation process, while it rather depended on wind speed in evaporation process. The comparisons in RH-wetness relations between leaf characteristics showed that broad-leaved grasses tended to be wetter than thin grasses.